

## SOILS OF THE FLOOD PLAIN OF THE MUREŞ (MAROS) RIVER

SÁMUEL JAKAB

### Introduction

Along its 768-km route the Mureş River - the most important tributary of the Tisza River - crosses several relief features with varying lithological structures, which leave their marks on the soil cover of the flood plain, including the active flood plain.

Having its source in Hâşmaşu Mare (Nagy Hagymás) Mountain, the Mureş River steps in the Intracarpathian fluviolacustrine Depression of Giurgeu, a large, poorly drained Quaternary subsidence zone, surrounded by a mountainous area built of silicatic metamorphic rocks, on the one hand, and volcanic andesitic rocks, on the other. All alluvia arriving in the bottom of the depression consists of deposits from gravel to fine sand, originating from these surrounding mountains.

Leaving this depression area, the Mureş crosses its longest gorge - Topliţa - Deda - (60 km) through volcanic mountains. The alluvia consists of coarse gravel with few fine particles, mostly andesitic.

At its emergence from the narrows through the volcanic mountains (Deda), the river flows at first in a Quaternary palcodeelta, developed exclusively in the subsidence zone, at the contact point of the mountain. This hinterland fandelta is situated between the foot of the mountain and the mouth of the Gurghiu River, a tributary of the Mureş, near Reghin. On this extent the alluvial deposits consist of a mixture of coarse andesitic gravel, sand and fine particles, the two latter originating from the nearby piemontane region.

The further path of the river cuts the large Transylvanian Plateau, a relief developed on friable Sarmatian and Pliocene deposits, consisting mostly of pelitic-pschitic, and subordinately of psamitic sediments (marly clay, sandy clay, loam and bench of sand). Consequently, the recent alluvia of the river are, in most cases, bad water conductors, finely granulated, rich in lime.

Breaking through the diapir zone of Ocna Mureş - Teiuş, the alluvia of Mureş frequently becomes salty.

Due to the nearness of the South Carpathians (Sebeş Mountains) and Apuseni Mountains along the Alba Iulia - Orăştie trough-like depression, and mainly in the Deva - Zam gorge, the alluvial deposits are coarser and contain less lime, than that in the section of the Transylvanian Plateau.

At the issue from the mountain at Lipova the Mureş flows on a succession of self-built deltas, situated between the foot of the mountain and the mouth of the river, belonging to the low-level Holocene area of the southeastern Hungarian Plain.

Prior to river regulation in this deep alluvial area, the running waters wandered freely, virtually without beds, due to the very low gradients in the region.

Nowadays, several sections of the Mureş River are regulated, and flood-control levees have been erected.

## Materials and Method

In this paper we present the soil cover of the flood plain of the Mureş River, on a scale of 1:300 000. Within the limits of the flood plain, the active flood plain represents frequently a relative narrow stripe, extremely difficult to delineate at the scale we used.

We present the soil map of the flood plain on fourteen sheets, with a profile of the significant soils found in the presented area sketched on each.

The materials used consist of soil maps published by the Romanian Research Institute of Pedology and Agrochemistry<sup>(10,11,12,13,14)</sup>, soil maps of Mureş County<sup>(6)</sup> and Hunedoara County<sup>(15)</sup> and several other published or unpublished soil surveys and studies.

In compiling Table 1 we have used data from the offices of Pedology and Agrochemistry of counties intersected by the Mureş River, as well as proper ones. In all chemical procedures air-dry samples were crushed, care being taken to avoid fragmenting nonsoil material, to pass a 2-mm roundhole sieve. Material retained by the sieve was reported as greater than 2 mm. All determinations were performed on the less than 2 mm fraction, and results were reported on this basis.

The heavy metal analyses were performed by means of atomic absorption spectrophotometric analysis (PYE-UNICON, Model SP-2900), in order to determine if any heavy metal pollution exists.

The soils of the flood plain, in particular those of the active flood plain, are of great importance for aquatic biocoenoses, generally for the state of running water, for many reasons. First of all, the soil cover is an important natural filter, which retains in large quantities the waste products. Its efficiency depends considerably on certain soil characteristics affecting permeability, cation mobility, such as clay, humus, pH, and their integration as cation-exchange capacity. Secondly, as a component of riverside biotopes, the soils of the flood plain determine to a great extent the nature, the structure of biocoenoses.

Table 1. Physical and chemical characteristics of several soil samples

Soil	Clay %	pH-H <sub>2</sub> O	Org.mat. %	CaCO <sub>3</sub> %	P ppm	K ppm	HCO <sub>3</sub> (mg/100g)	Cl (mg/100g)	SO <sub>4</sub> (mg/100g)	T (mg/100g)	Na % from T
AP1- Morăreni											
Ao 0-20 cm	15,4	7,8	1,78	0,41	41	69					
C 20-40 cm	15,4	7,8	1,22	0,41	23	45					
AP2- Sintana de											
Ao 0-30 cm	28,8	8,2	1,87	0,50	39	78					
C1 30-75 cm	16,5	8,2	0,85	0,40	27	78					
C2 75-(120) cm	13,4	8,2	-	0,50	-	-					
AP3- Chelmac											
Ao 0-30 cm	36,9	8,0	2,30	0,69	31	79					
AC 30-45 cm	36,8	7,8	1,60	0,20	8	51					
C 45-(120) cm	30,2	8,2	0,60	0,30	-	-					
AP4- Deva											
Ao 0-30 cm	8,7	8,0	1,09	1,73	67	110					
C1 30-60 cm	18,8	8,0	0,91	2,32	25	85					
CGo 60-(120) cm	27,5	8,0	1,29	3,12	-	-					
AP5- Zam											
Ao 0-20 cm	24,2	7,9	1,2	2,40	72	170					

Soil	Clay %	pH-H <sub>2</sub> O	Org.mat. %	CaCO <sub>3</sub> %	P ppm	K ppm	HCO <sub>3</sub> (mg/100g)	Cl (mg/100g)	SO <sub>4</sub> (mg/100g)	T (mg/100g)	Na % from T
AC 20-50 cm	36,0	7,8	0,7	1,70	44	150					
CGo 50-(120) cm	34,2	8,0	0,6	2,60	-	-					
AS1- Ogra											
Ao 0-70 cm	30,7	7,8	2,45	2,3	156	170					
AC 70-80 cm	28,5	7,8	2,23	2,0	48	100					
C 80-(150) cm	28,4	7,9	0,65	1,6	-	-					
AS2- Deda											
Ao 0-40 cm	27,0	6,5	3,42	0,0	34	14					
R 40-(80) cm	4,2	6,2	0,14	0,0	-	-					
AS3- Pecica											
Ao 0-50 cm	43,4	8,0	2,77	8,8	20	155					
C1 50-70 cm	30,9	8,4	2,35	5,3	15	105					
C 70-(120) cm	18,7	8,6	0,37	5,1	-	-					
AS4- Deda											
Ao 0-30 cm	27,7	7,2	3,84	0	36	150					
30-60 cm	27,8	7,1	1,17	0	11	80					
CGor 60-(120) cm	33,0	7,0	0,82	0	-	-					
AS5- Oena Mures											
Ao sc 0-40 cm	39,0	8,7	2,98	4,4	17,0	120	61,0	12,4	144		
AC sc 40-60 cm	38,0	8,8	1,80	4,7	15,0	107	42,7	14,2	120		
CGo sc 60-(120) cm	36,0	8,7	1,07	14,6	10,0	98	24,4	17,8	105		
AS6- Conad											
Am 0-30 cm	43,1	7,5	4,0	9,2						29,5	2,13
Cna 30-85 cm	38,3	9,2	0,8	9,2						29,1	17,10
CGona 85-(120) cm	40,3	9,4	0,5	7,9						-	-
LG1-Dova											
AGo 0-50 cm	11,5	8,1	1,05	13,23	16	70					
Gr 50-(120) cm	18,0	7,8	-	4,90	-	-					
LG2- Singeorgiu de											
Ao 0-25 cm	50,5	7,6	3,88	1,5				14,7	12,5		
AGo 25-40 cm	49,5	7,8	2,98	2,1				51,8	2,5		
Gor 40-(120) cm	61,5	8,0	1,39	1,1				21,7	2,0		
IIg1- Joseni											
Am 0-20 cm	33,0	5,4	6,0	0	6	80					
Gr 20-70 cm	13,2	5,6	2,7	0	21	50					
HG2- Toplita											
Am 0-25 cm	57,0	5,1	5,91	0	78	130					
AGr 25-40 cm	58,2	5,0	5,08	0	-	-					
Gr 40-100 cm	60,4	5,0	-	-	-	-					
HG3- Teisus											
Am sc 0-50 cm	31,0	8,2	3,20	2,7	28	70	61,0	12,4	144		
AGo sc 50-70 cm	38,9	8,5	1,10	0,6	-	-	42,7	14,2	120		
Gr 70-(120) cm	52,0	8,7	-	7,3	-	-	24,4	17,8	105		
LDG- Orăstie											
Am 0-45 cm	47,0	7,6	3,10	-	22	178					
Cna 45-64 cm	51,0	8,3	2,30	4,3	11	164					
CGona 64-(120) cm	42,0	8,6	0,72	4,6	10	125					
TB- Voslobeni											
T1 0-25 cm	0	7,5	32,00	16	39						
T2 25-70 cm	0	7,0	26,60	136	27						
Gr 70-(120) cm	0	7,4	2,32	-	-						

### Short description of soils

Characteristics of the soils described in this paper are presented in Table 1. Four groups of soil have been found in the flood plain of the Mureş River, as follows: alluvial protosoils, alluvial soils, gley soils and peaty soils.

#### *Alluvial protosoil*

The recent formations of the flood plain are represented by alluvia or alluvial protosoils. In most cases the soil-forming processes are incipient or absent, because of more or less frequent flooding that hinders pedogenesis. The spreading of alluvial protosoils is limited to the active flood plain, or the flood-controlled stripe.

Generally, the alluvial protosoils are stratified, having in most cases a loose consistency and coarse texture (gravels, sands, loamy sands), but here and there, they also can be moderately coarse-textured (sandy loam) and medium-textured (loam and silt). This group of soils has a low organic matter and clay content, consequently a weak cation-exchange capacity and low retaining power, mostly the coarse-textured ones. The lime content and in connection with this the pH-value vary along the river, but they do not limit plant growth.

Due to their particle-size distribution and the lack of an impermeable layer, even in the deeper levels, most of the alluvial protosoils are excessively permeable, therefore they cannot retain a great part of the substances which pollute the running water. In this respect the storage of various wastes on the active flood plain can be harmful for the river, however the heavy metal analysis of some soil samples originating from the active flood plain did not show any sign of pollution (Table 2).

When the alluvial protosoils are covered with vegetation, their retaining and filtering power becomes more efficient. Consequently, in order to enhance the retaining and filtering power of these soils, forestation with poplar species is desirable.

**Table 2.** Heavy metal concentration of some soil samples of the active flood plain in mg/kg dry matter

Characteristic Soil	1	2	3	4	5	6
pH-H <sub>2</sub> O	6.6	6.6	5.3	5.9	8.0	7.9
Clay, %	0	13.2	36.0	13.0	25.6	19.6
Org. Matter, %	22.7	2.0	3.9	9.0	4.4	4.0
Cd, mg/kg	0	0	0	0	0.2	0.1
Cr, mg/kg	0	0	0	0	21.0	17.0
Cu, mg/kg	0	0	0	0	0	0
Fe, mg/kg	0	382	478	400	23.0	123
Mn, mg/kg	0	118	100	118	104	87
Ni, mg/kg	0	0	0	0	0	0
Pb, mg/kg	0	0	0	0	0	0
Zn, mg/kg	0	0	5	19	0	7

Provenance of soil samples: 1. Voslobeni; 2. Senetea; 3. Remetea; 4. Lunca Bradului; 5. Lermut - Cipau; 6. Teius.

#### *Alluvial soils*

The alluvial soils occupy most of the parts of the floodwater-free, or rarely flooded, higher level of the river plain, being in various stages of development and fertility. Contrary to alluvial protosoils, their upper-A<sub>0</sub> or A<sub>m</sub>- horizon is deep, with a humus content

exceeding 2-2.5%, reaching even 4% in some cases.

With the exception of those of the Toplița-Deda gorge, showing neutral or slightly acid reaction, all alluvial soils showed an alkaline reaction.

The clay content was also higher, as compared with alluvial protosoils, and varied from 27% to 43%. As a result of this higher clay content, the water penetrated through their profile is well filtered.

Generally having high fertility, the alluvial soils of the Mureș River are used almost totally as plough-land, in some cases employing irrigation.

The groundwater level fluctuates seasonally between 0.50 and 2.50 meters, in close connection with the water level of the river.

Though large quantities of fertilizers have been employed in the last decades, no chemical pollution of the soil cover could be proved. Nevertheless groundwater pollution with nitrates is not out of question.

Nearby the greater cities - Tîrgu Mureș, Alba Iulia, Deva, Arad - large amounts of waste are deposited on the flood plain, extensive surfaces of fertile alluvial soils being withdrawn from agricultural use, harming in the same time not only more or less broad neighbouring soil strips, but also the groundwater and running water, too.

An important source of soil - and groundwater pollution can be the waste-water purification plants, when because of frequently filling up of their drying beds, large amounts of sewage sludges are deposited directly on the soils, not far from the river.

#### *Gley soils*

Two groups of gley soils have been distinguished: low humic gley soils and humic gley soils. Both are hydrogenic soils with high groundwater levels during a long period of the year.

Most of this soil type have a high clay content, and thus are bad water conductors. The most extensive occurrence of the gley soils is in the Intracarpathian fluviolacustrine Depression of Giurgeu. After emerging from the volcanic mountains, the gley soils are spread mainly in the deep-lying marginal areas of the flood plain. The important river-regulation and floodwater-prevention works performed, especially downstream from Arad, led to many changes in the position of the riverbed. As a result, the present flood plain is full of cut-off branches and oxbows, filled with poor water-conducting silty and clayey materials, favorable for hydrogenic soil-forming processes.

On these soils grows generally a luxuriant herbaceous vegetation, representing not only an important fodder source for cattle, but at the same time a favourite transitional place for some migratory birds. Transformation of these soils into farmland is not indicated.

#### *Peaty soils*

In the upper course of the Mureș River, a considerable part of the active flood plain is covered by a thick organic matter layer, partly transformed into peat or peaty soil. Their existence is due to a permanent water supply from lateral thick alluvial fans, that maintain a high groundwater levels. As a result the organic matter layer is saturated permanently. Near Voslobeni, in these waterlogged soils grow some relic plants of the last glacial period. Protection of these relicts by law is necessary.

## Conclusions

On the flood plain of the Mureş River, four groups of soils were distinguished: alluvial protosoils on the active flood plain with a low retaining and filtering power, alluvial soils on the greatest part of the floodwater-free higher level of the river plain, gley soils on the marginal deep lying areas of the flood plain, and peaty soils in the upper course of the river.

No harmful chemical pollution of the soil cover could be proved along the entire course of the river. Some exceptions exist, however, mainly around the waste-water purification plants of the greater cities.

In order to enhance the retaining and filtering power of the alluvial protosoils on the active flood plain, forestation with popular species is recommended.

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*Sâmuel. Jakob, Alea Carpați 39, 4300 Tîrgu Mureș, Romania*







Figs. 1-14. The soil cover types of the flood plain of the Mure<sup>o</sup> River.

# LEGEND OF SOILS







## I. ALLUVIAL PROTOSOILS

	AP1	Loamy sandy stratified alluvial protosoil on gravelly andesitic substratum.
	AP2	Loamy sandy and sandy stratified alluvial protosoil on sandy substratum.
	AP3	Sandy loam alluvial protosoil on loamy substratum.
	AP4	Deep gley loamy alluvial protosoil on sandy loam or loam.
	AP5	Moderately gleyed silty alluvial protosoil on silty substratum.


## II. ALLUVIAL SOILS

	AS1	Loamy alluvial soil on sandy loam.
	AS2	Loamy sandy skeletal alluvial soil on gravelly andesitic substratum.
	AS3	Loamy and clayey loam alluvial soil on sandy loam and silt.
	AS4	Deep gley sandy loam alluvial soil on sandy loam and silt.
	AS5	Salt-affected poorly drained alluvial soil on salt clay.
	AS6	Alkali alluvial soil on clayey substratum with cut-off branches and remnants of oxbow lakes

## III. GLEY SOILS

	HG1	Low humic gley soil on sandy substratum.
	HG2	Low humic gley soil on silty and clayey substratum.
	HG3	Humic gley soil on gravelly andesitic and silicatic substratum.
	HG4	Humic gley soil on silty and clayey substratum.
	HG5	Salt-affected humic gley soil on silty and clayey substratum.
	DG	Drained humic gley soil on silty substratum.

## IV. PEATY SOILS

	TB	Peaty soil on gravelly andesitic and silicatic substratum.
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## OTHER SIGNS





	Water covered area
	Place of soil samples
	Regulated river section
	Floodcontrol level



Fig.1.

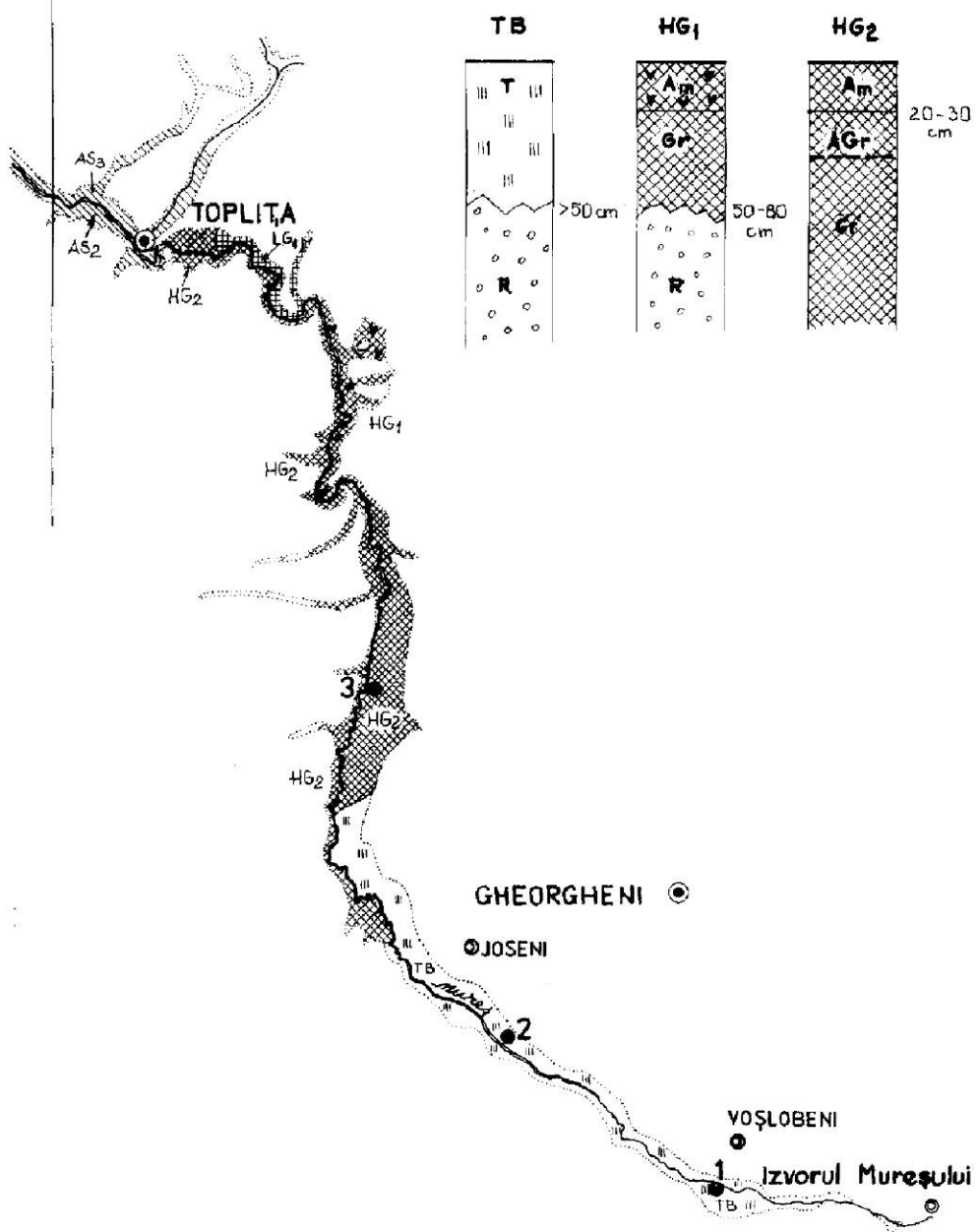


Fig.2.

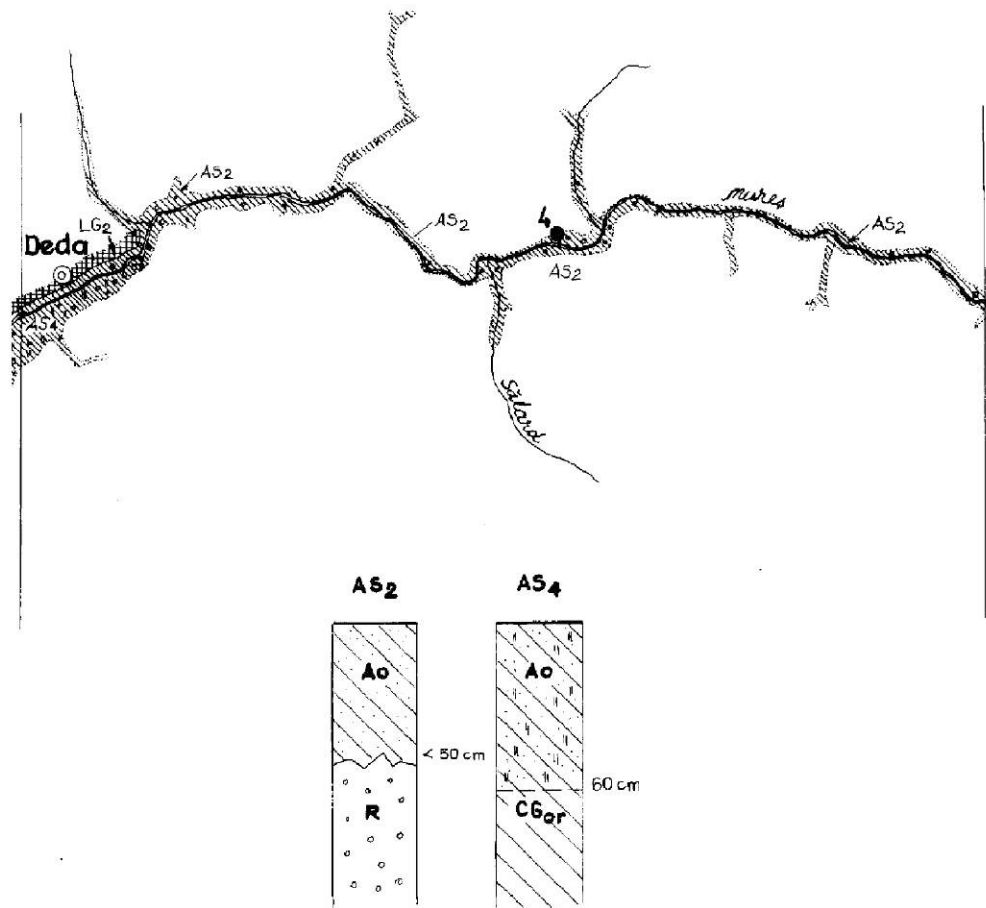


Fig. 3.

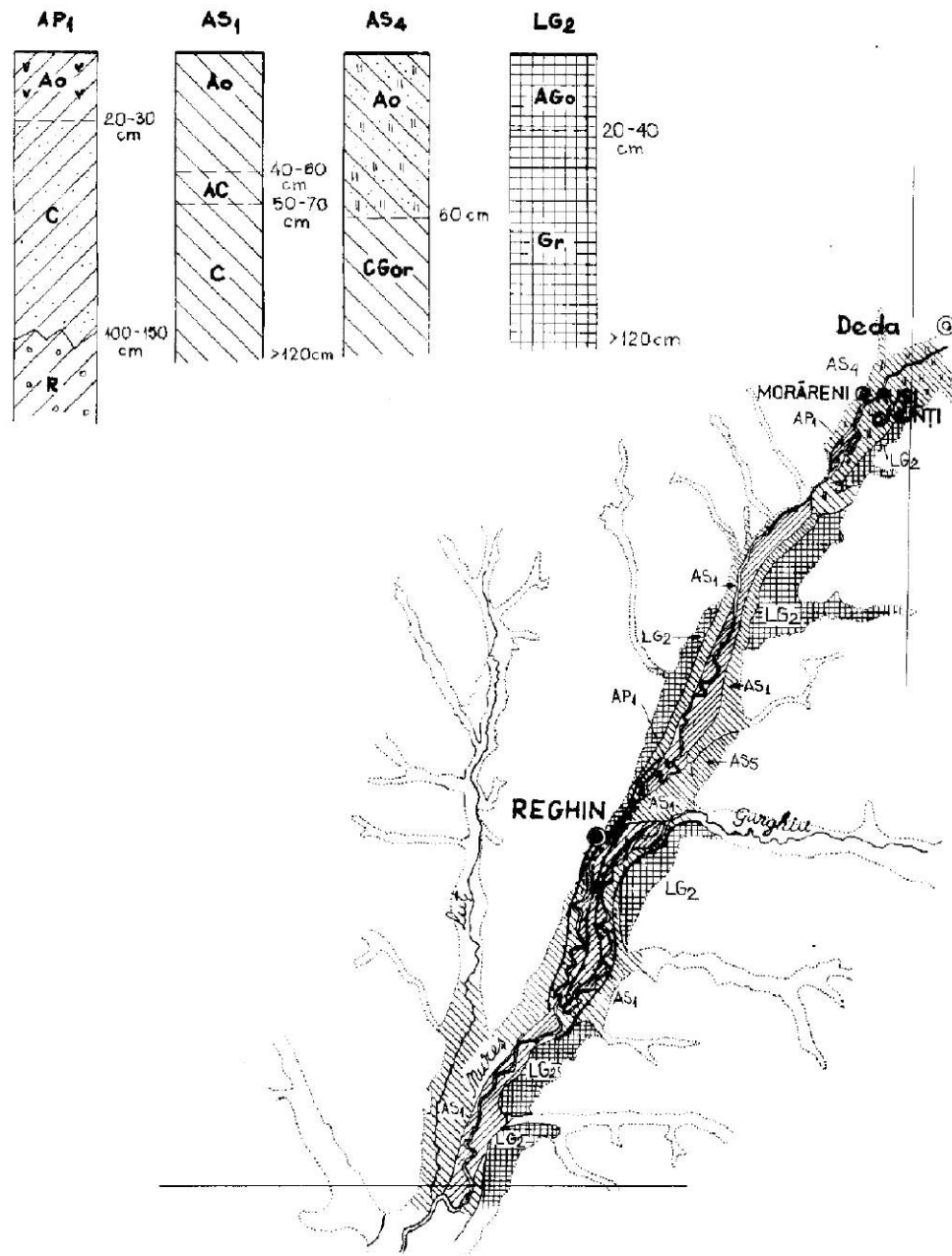


Fig. 4.

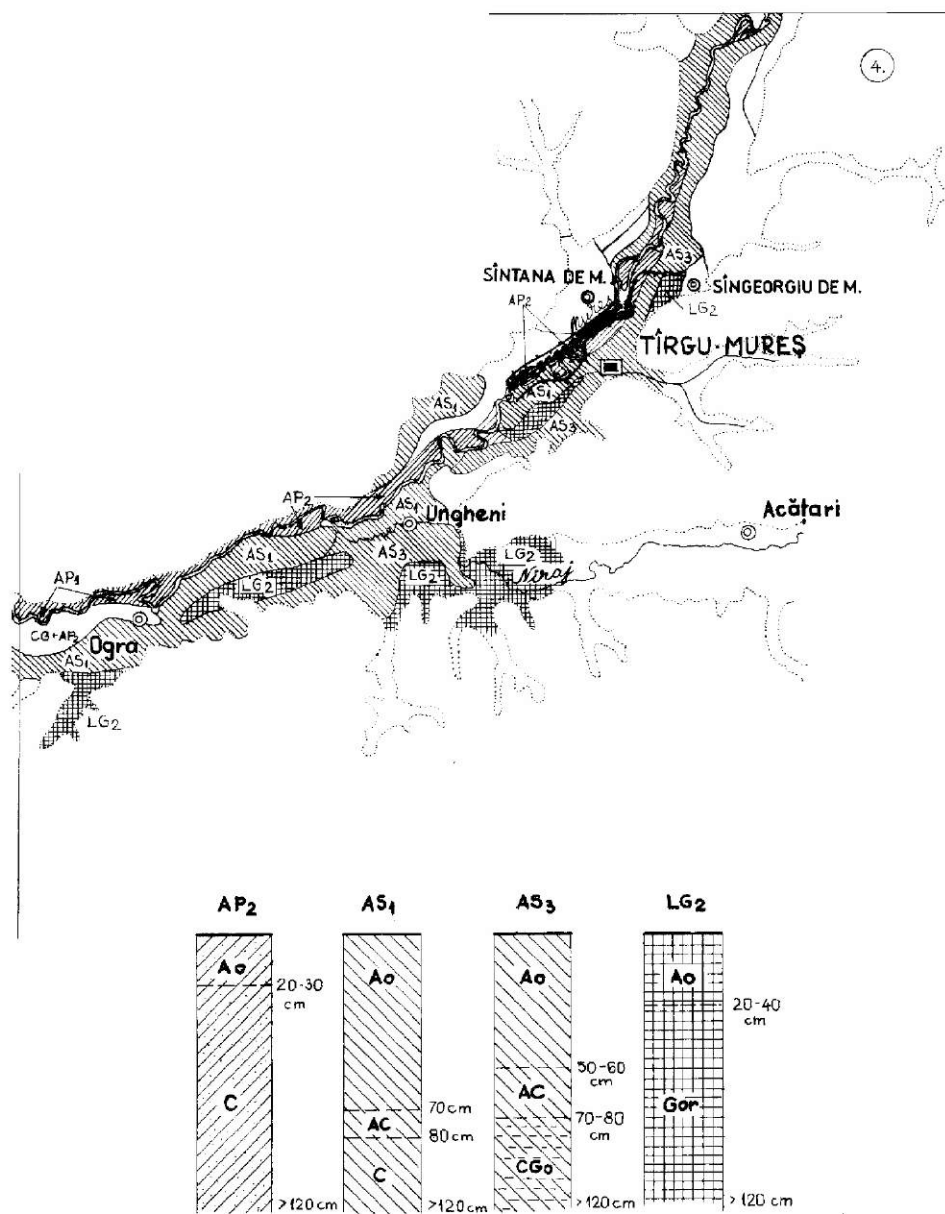


Fig. 5.

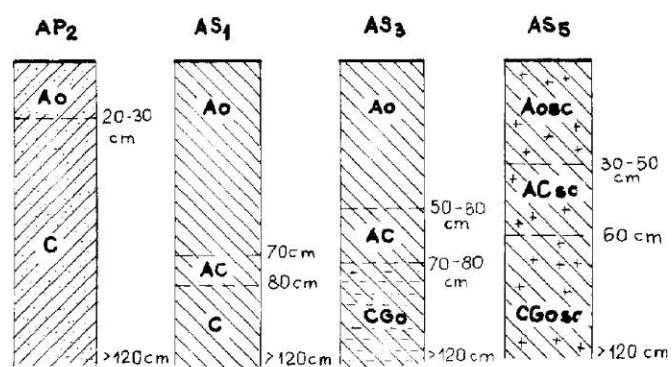
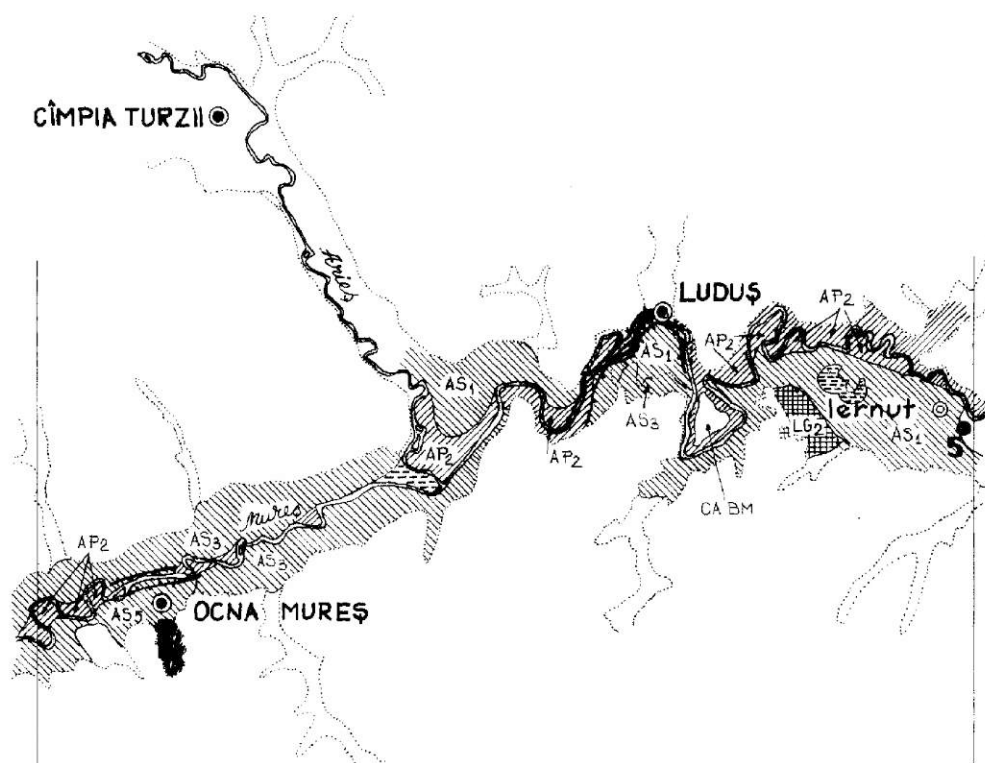


Fig. 6.

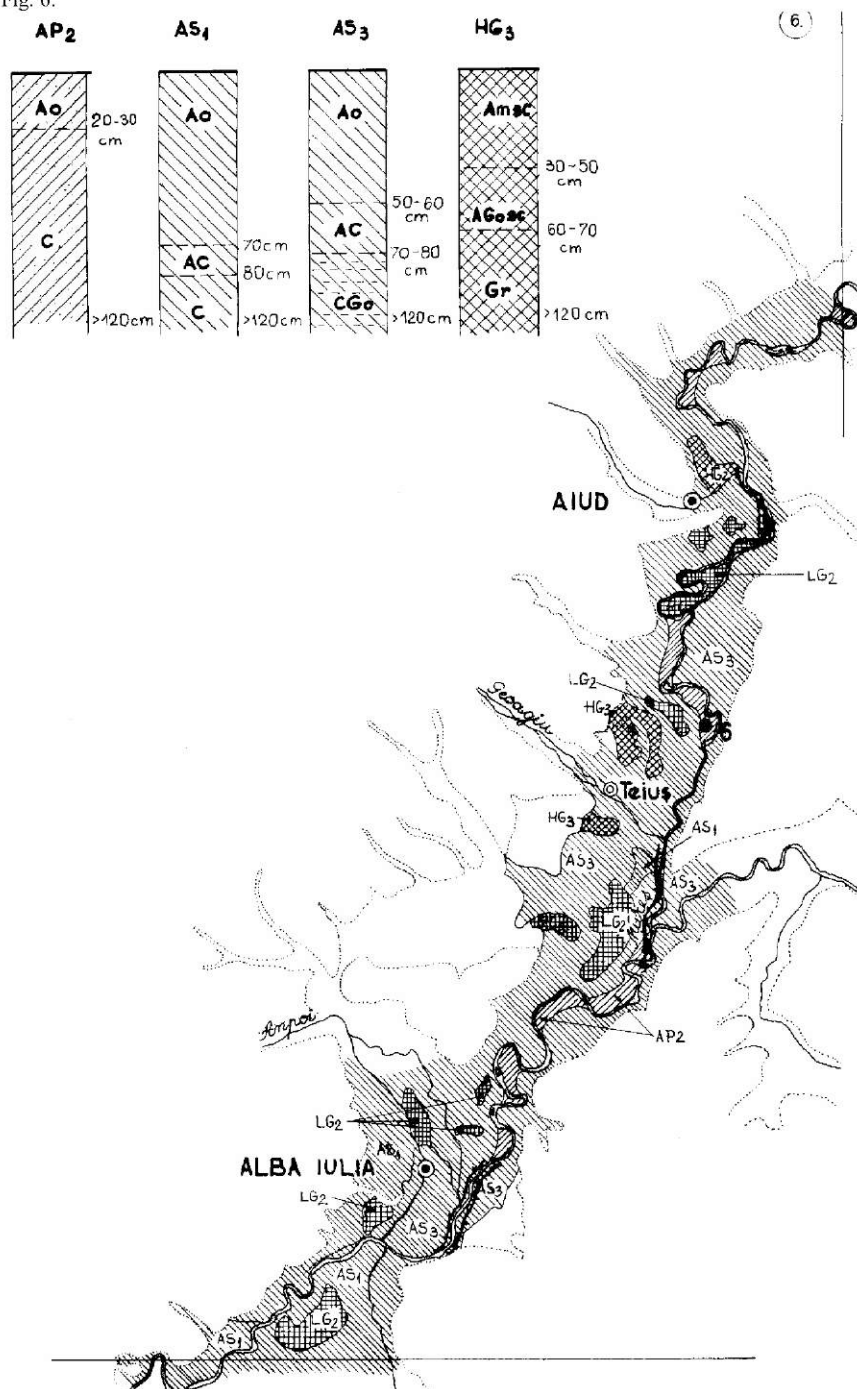


Fig. 7.

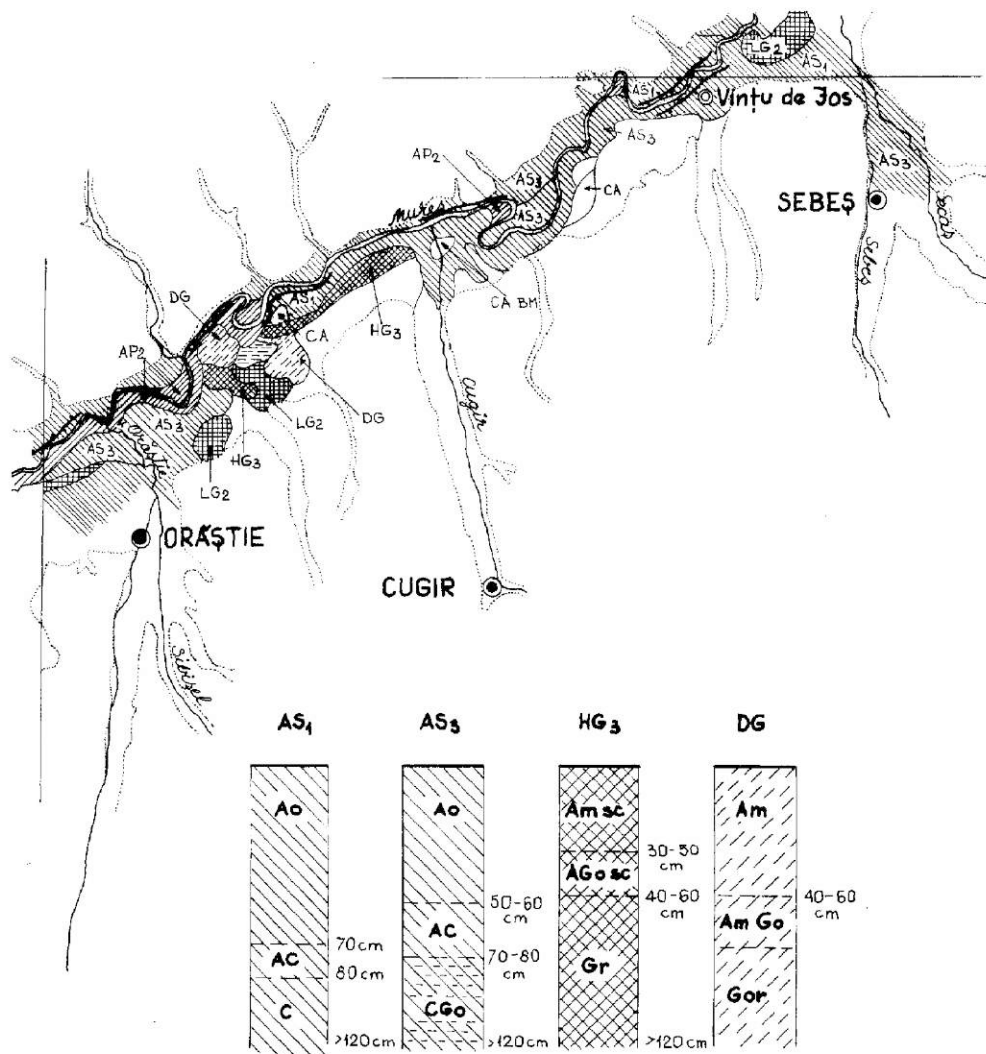


Fig. 8.

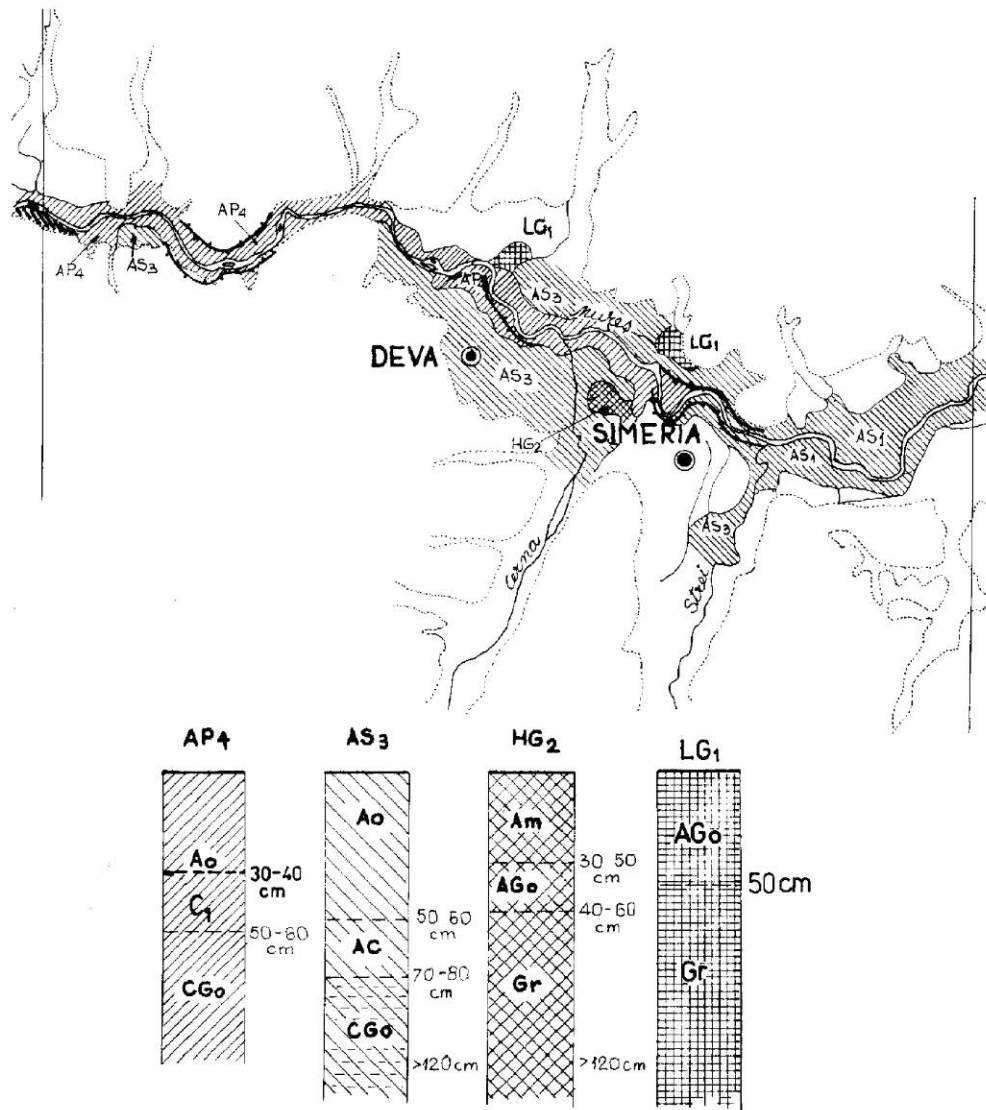




Fig. 9.

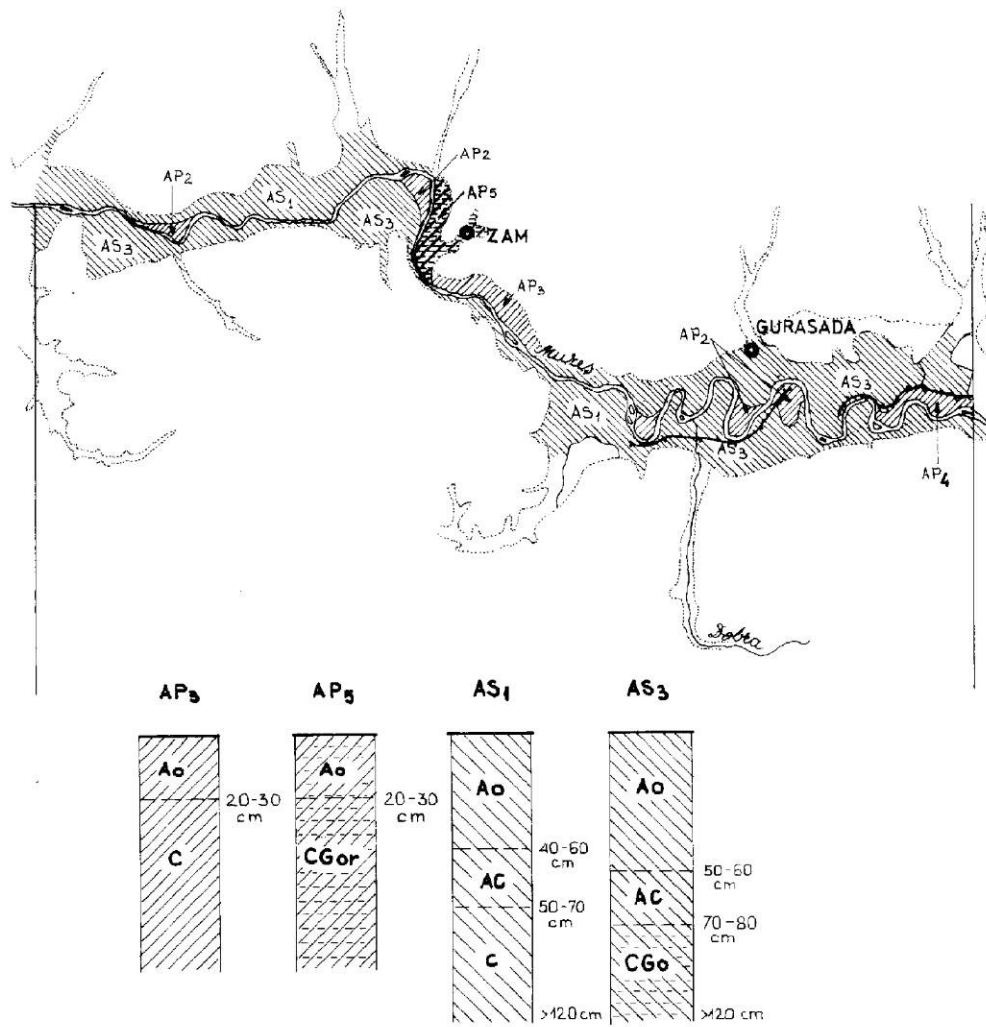
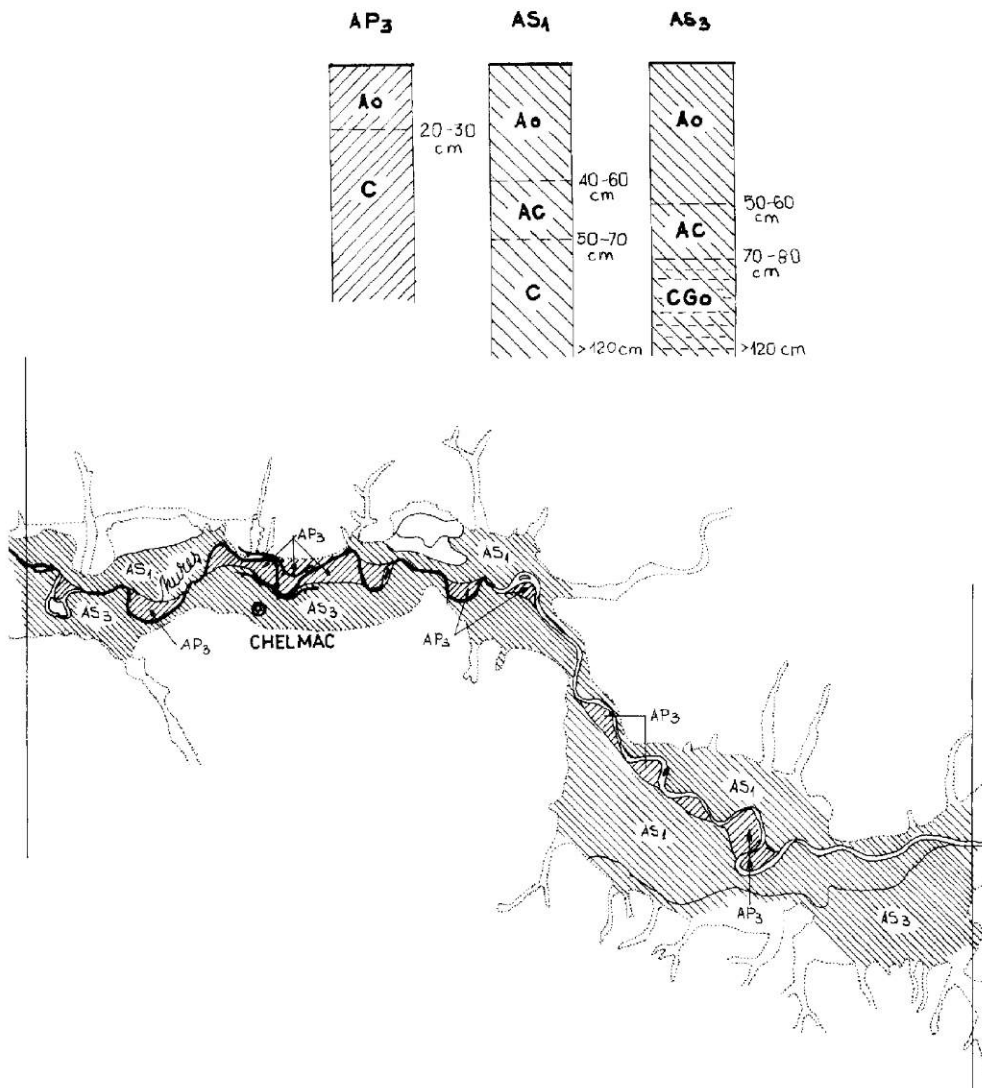


Fig. 10.



Fug. 11.

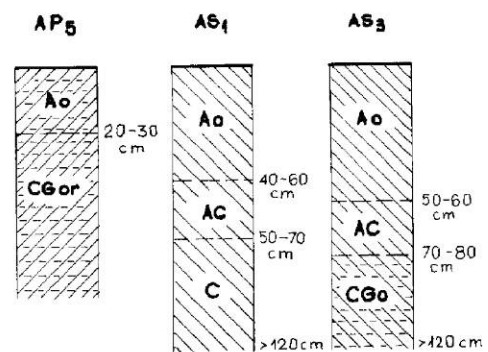
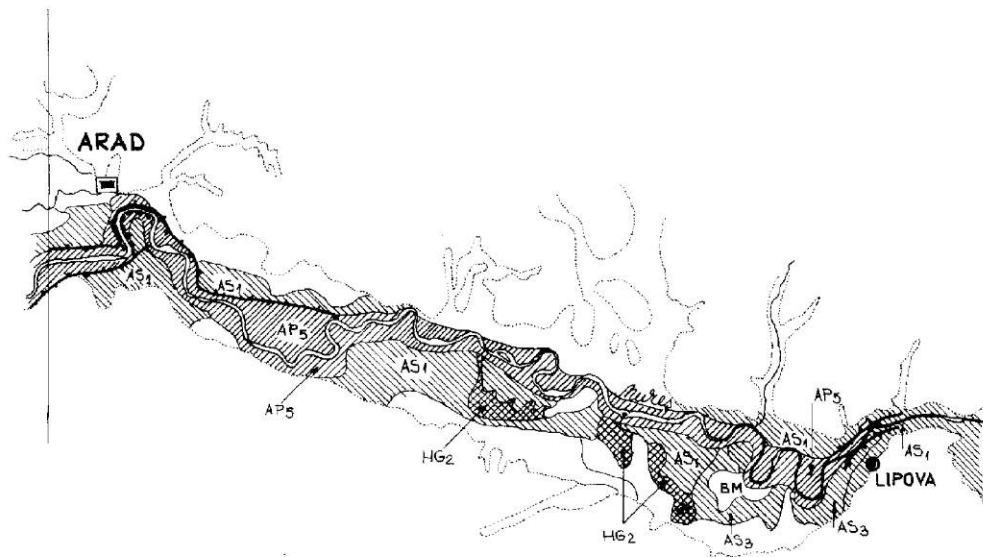


Fig. 12.

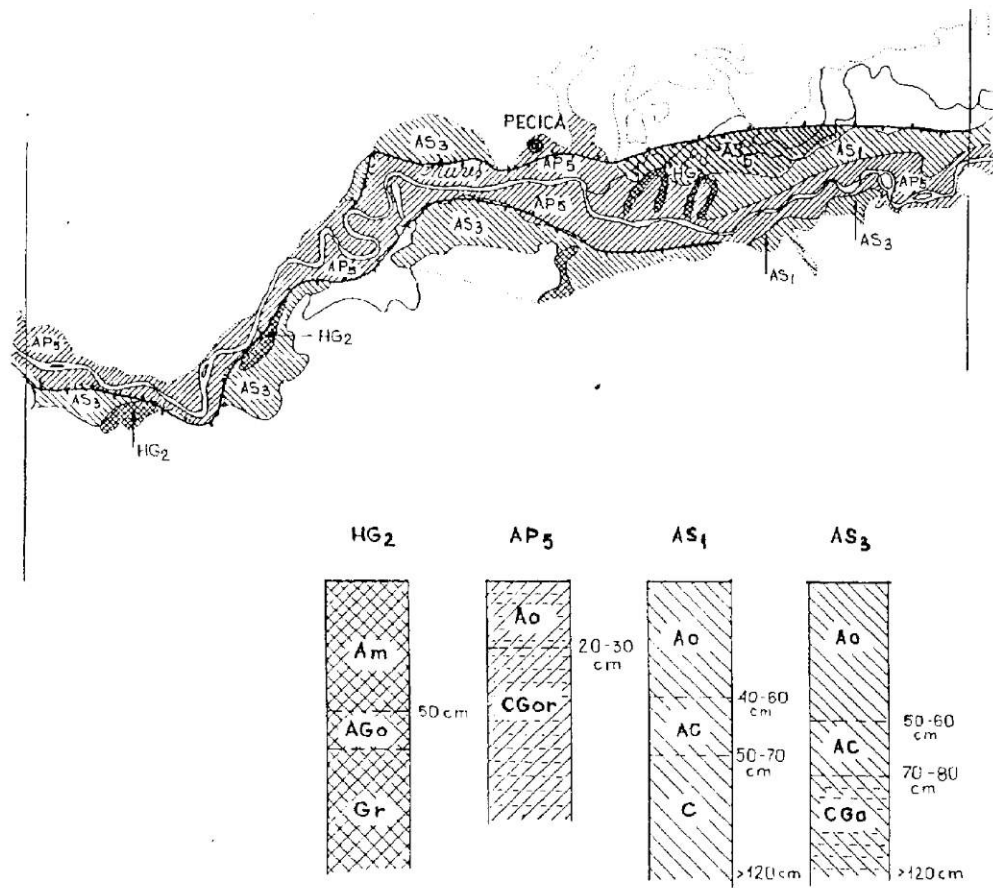


Fig. 13.

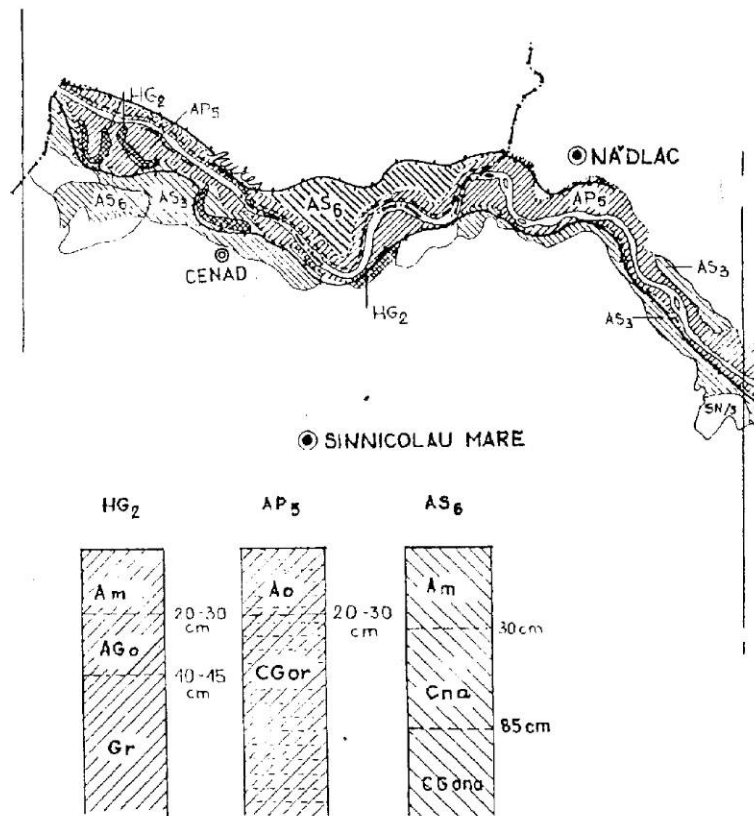


Fig. 14.

